US006770182B1

(12) **United States Patent**
Griffiths et al.

(10) **Patent No.: US 6,770,182 B1**
(45) **Date of Patent: Aug. 3, 2004**

(54) **METHOD FOR PRODUCING A THIN SAMPLE BAND IN A MICROCHANNEL DEVICE**

(75) Inventors: **Stewart K. Griffiths**, Livermore, CA (US); **Robert H. Nilson**, Cardiff, CA (US)

(73) Assignee: **Sandia National Laboratories**, Livermore, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 650 days.

(21) Appl. No.: **09/714,410**

(22) Filed: **Nov. 14, 2000**

(51) **Int. Cl.**[7] **G01N 27/26**; B01D 57/02

(52) **U.S. Cl.** **204/453**; 204/450; 204/451; 204/454

(58) **Field of Search** 204/450, 451, 204/453, 454

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,429,728 A	*	7/1995	Gordon	204/453
5,750,015 A	*	5/1998	Soane et al.	204/454
5,858,195 A	*	1/1999	Ramsey	204/601
6,080,295 A	*	6/2000	Parce et al.	204/451
6,375,817 B1	*	4/2002	Taylor et al.	204/453
2002/0008028 A1	*	1/2002	Jacobson et al.	204/451

FOREIGN PATENT DOCUMENTS

JP 05072178 A * 3/1993 ..... G01N/27/447

OTHER PUBLICATIONS

Ermakov et al., "Computer Simulations of Electrokinetic Injection Techniques in Microfluidic Devices," Anal. Chem. 72, pp. 351 3517 (Jun. 2000).*

* cited by examiner

Primary Examiner—Nam Nguyen
Assistant Examiner—Brian L Mutschler
(74) *Attorney, Agent, or Firm*—Timothy P. Evans

(57) **ABSTRACT**

The present invention improves the performance of microchannel systems for chemical and biological synthesis and analysis by providing a method and apparatus for producing a thin band of a species sample. Thin sample bands improve the resolution of microchannel separation processes, as well as many other processes requiring precise control of sample size and volume. The new method comprises a series of steps in which a species sample is manipulated by controlled transport through a junction formed at the intersection of four or more channels. A sample is first inserted into the end of one of these channels in the vicinity of the junction. Next, this sample is thinned by transport across the junction one or more times. During these thinning steps, flow enters the junction through one of the channels and exists through those remaining, providing a divergent flow field that progressively stretches and thins the band with each traverse of the junction. The thickness of the resulting sample band may be smaller than the channel width. Moreover, the thickness of the band may be varied and controlled by altering the method alone, without modification to the channel or junction geometries. The invention is applicable to both electroosmotic and electrophoretic transport, to combined electrokinetic transport, and to some special cases in which bulk fluid transport is driven by pressure gradients. It is further applicable to channels that are open, filled with a gel or filled with a porous or granular material.

22 Claims, 20 Drawing Sheets